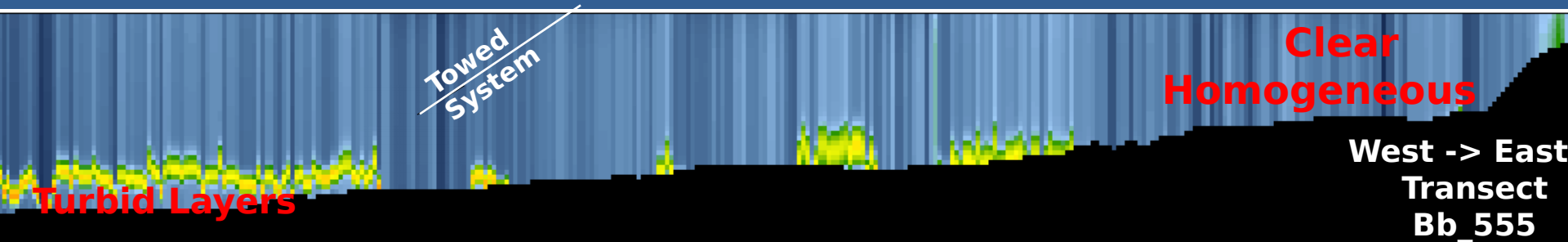




# Forecasting the Ocean Optical Environment for EO Performance Surfaces

New capability to support the HM Squadron's  
ASQ 24 and diver operations using  
Gliders , Models and Remote Sensing



Sherwin Ladner, Robert Arnone  
Ocean Processes Branch  
Naval Research Laboratory



# Tactical Ocean Data System (TODS) Components



- **LAGER** - Quality control of glider optical and physical properties
  - Deployment, Processing and data QC and analysis
- **OPCAST** - 2D Forecasting of Surface Optics out to 48 hours
  - Coupling Satellite optics and models
- **3DOG** - 3D Optical Volume Generator
  - Fusion of Gliders, Satellites and Models
- **Performance Surfaces** (EODES Model, Diver Visibility)
  - Linking the 3D optics with the AQS 24

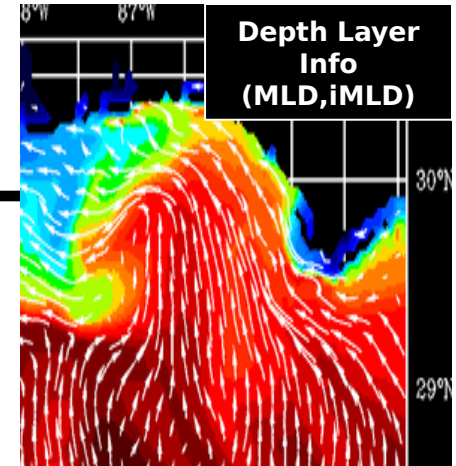
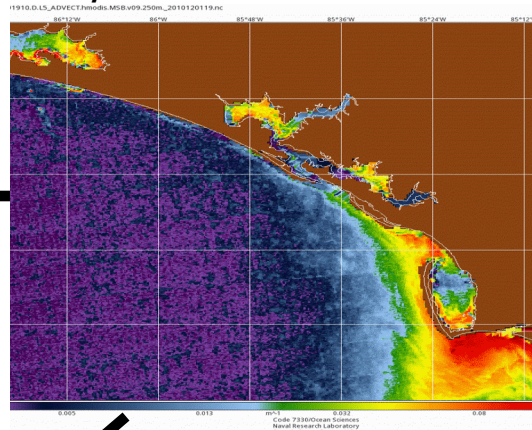
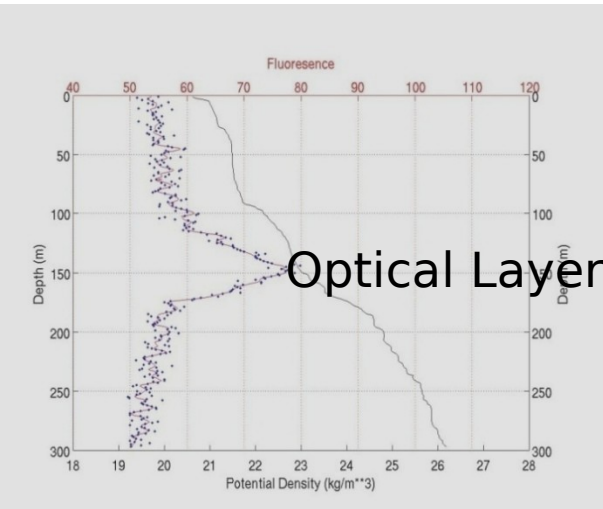


# Integration of Glider Profiles, Satellite and Numerical Models to support AQS24 Operations

Vertical Optical Profiles  
(Glider, BSP, etc.)

Nowcast / Forecast Satellite Optics

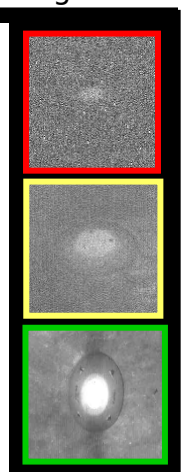
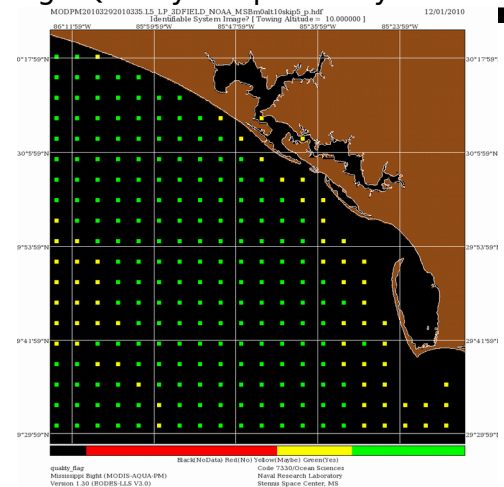
Nowcast / Forecast  
Circulation Models



**What Happens  
Below  
Satellite Surface  
Today and  
Tomorrow?**

**EODES**

Nowcast/Forecast Performance Surface  
Image Quality & Optimal System Towing Altitude



3D Optical Volume & Diver Visibility



# TODS Fleet Demonstration and Support Of EO Laser Imaging Performance

**Support provided to HM-14 HARP Exercise**

**VULCANEX 11-1 - Panama City, FL - March 30, 2011 - April 08, 2011**

TODS Support (Daily Brief Provided to Fleet):

- a) Nowcast/Forecast (24,48 hours) of the Optical Environment (2D & 3D) → Impact on laser system (ASQ 24) and diver visibility
- b) Nowcast/Forecast (24,48 Hours) 3D Optical Volume / Vertical Optical Layer
- c) Nowcast/Forecast (24,48 Hours) EOWS/AQS-24, ALMDS and diver performance surfaces
- d) Circulation models → 3Km NCOM-RELO
- e) Optical profiles collected in real-time using Slocum glider for assimilation into 3D Optical Volume (Tuning Coefficients defining the optics to physics relationship)
- f) End-to-end testing and evaluation of TODS system components (OpCast, 3DOG <- glider optics profiles, performance surfaces <- AQS-24 snip)

## Vulcanex 11-1 Coordination Planning

Mark J. Reynolds

Technical Systems Integration, Inc. Oceanographer/Test and Evaluation

AMCM Tactics Support & Training Division Coordination

AMCM Weapon Systems Training School NSWC PCD

Kevin Oakes

Project Manager

AMCM Tactics Development

NSWC PCD, Code X32 (Tactics Branch) NSA PCD, N36

Beth Branham

Oceanographer/Test and Evaluation

Division Coordination

NSWC PCD

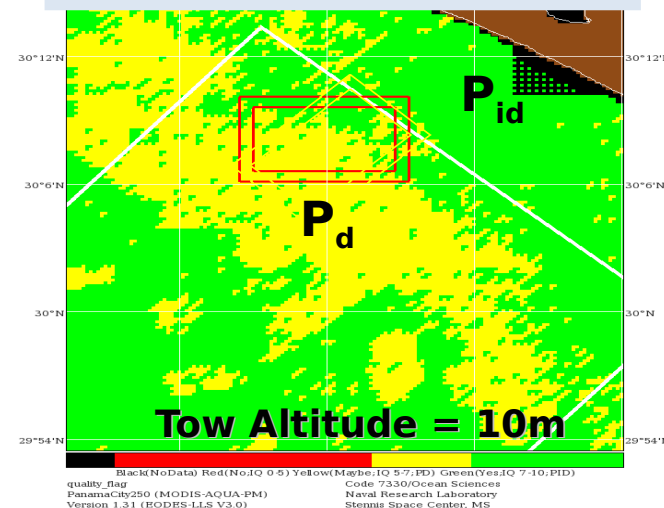
Jeffrey Willows

Op-Area Coordinator (Glider Activity)

Naval Support Activity

NSA PCD, N36

## EOW Performance Surface



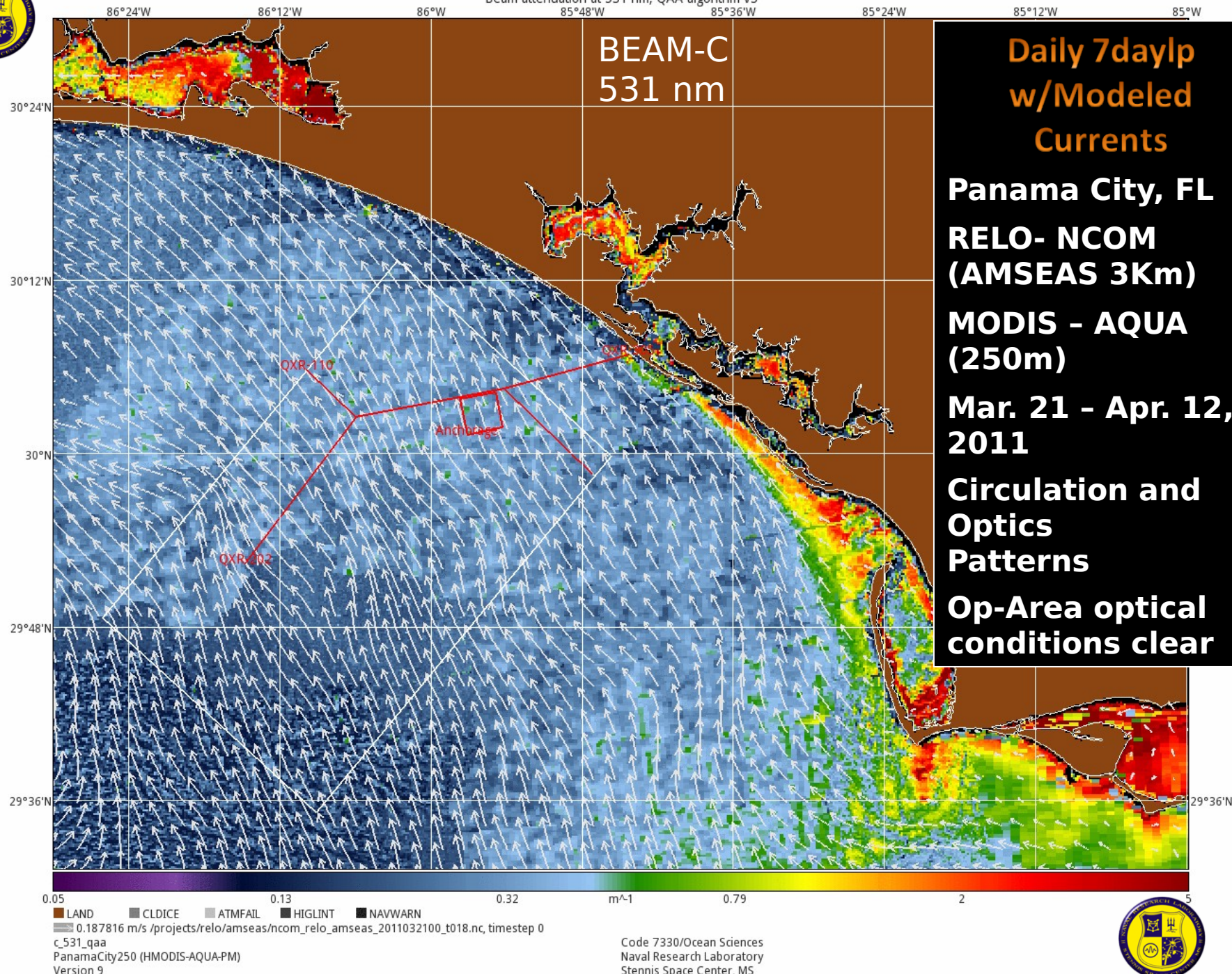




aqua.2011074.0315.2011080.0321.D.L4\_LP.hmodis.PAN.v09.250m.hdf

Beam attenuation at 531 nm, QAA algorithm v5

Mar 15-Mar 21, 2011 (1LP)

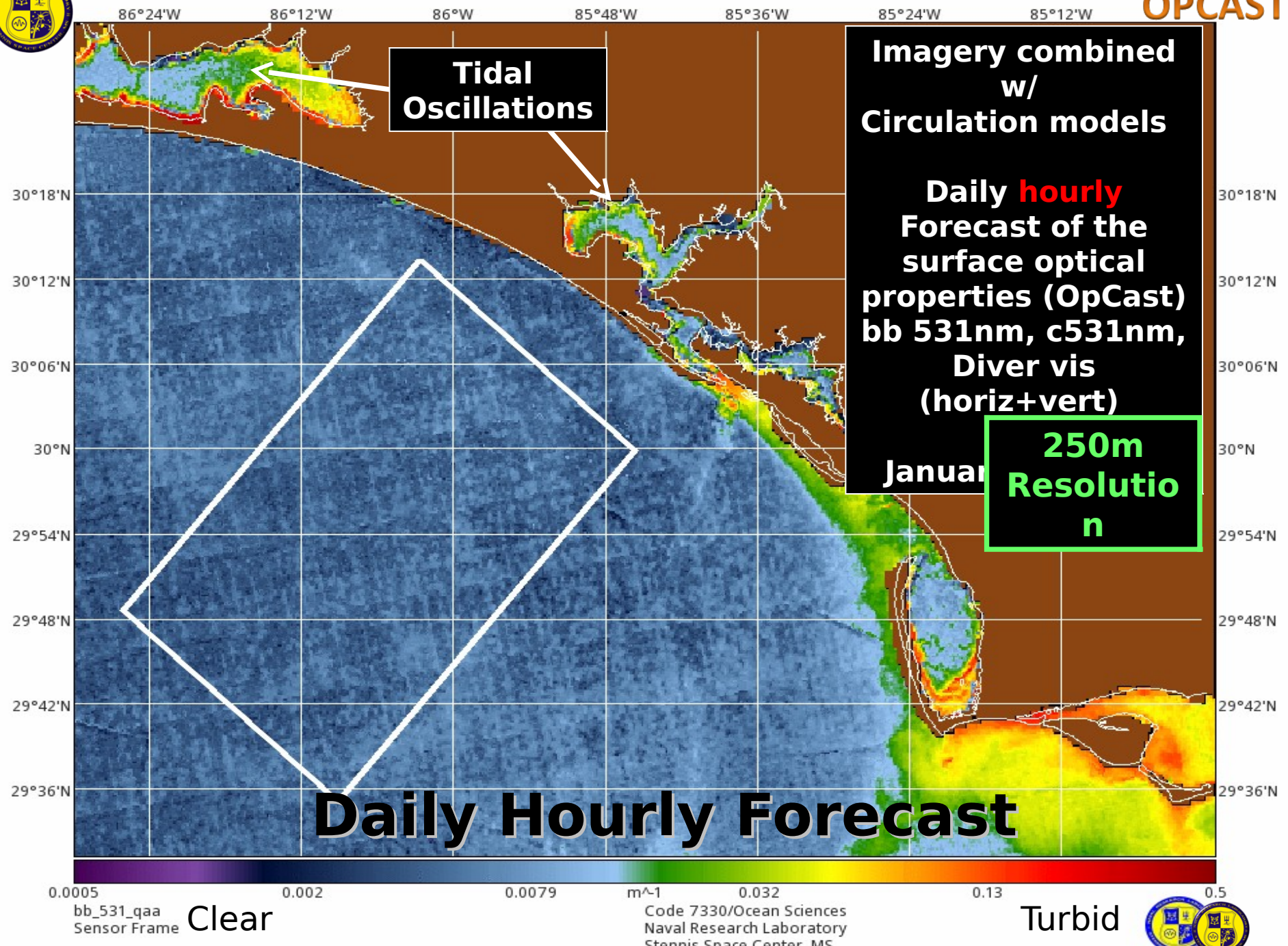






aqua.2011015.0115.184916.D.L5\_ADVECT.hmodis.PAN.v08.250m.\_20110115.18.nc

OPCAST



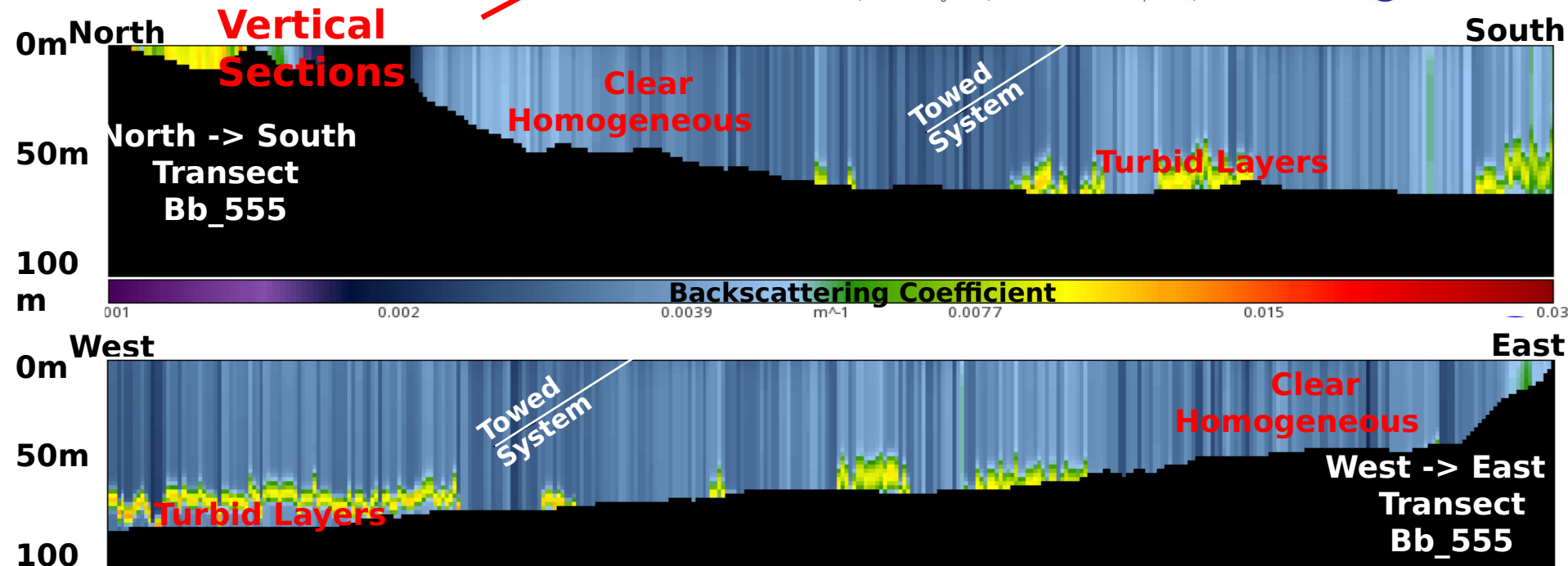
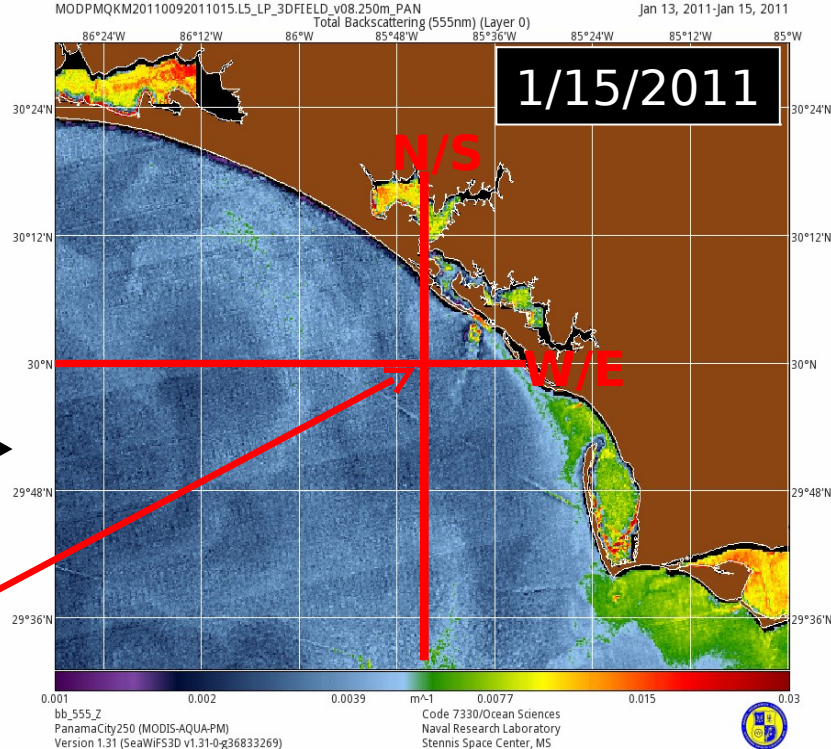


# 3DOG

**3D Optical Generator  
Merging  
“Satellite, models  
and  
Insitu data “  
Surface to Bottom  
Animation  
(Black Areas are Bottom)**

**250m  
Resolution  
Coefficient  
ts**

**Need  
Tuning  
Daily  
Using  
Slider**

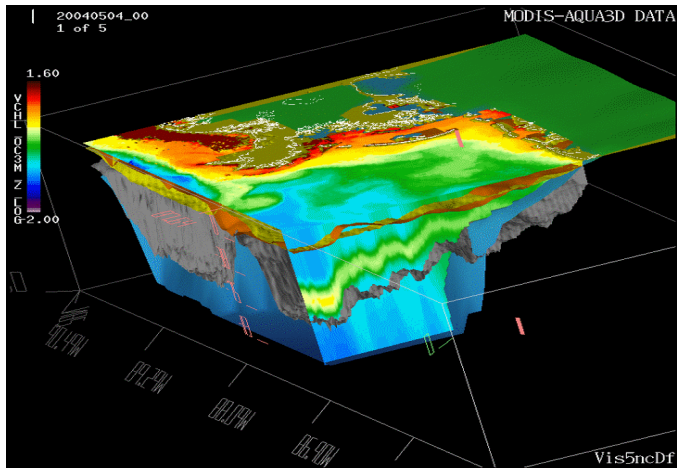




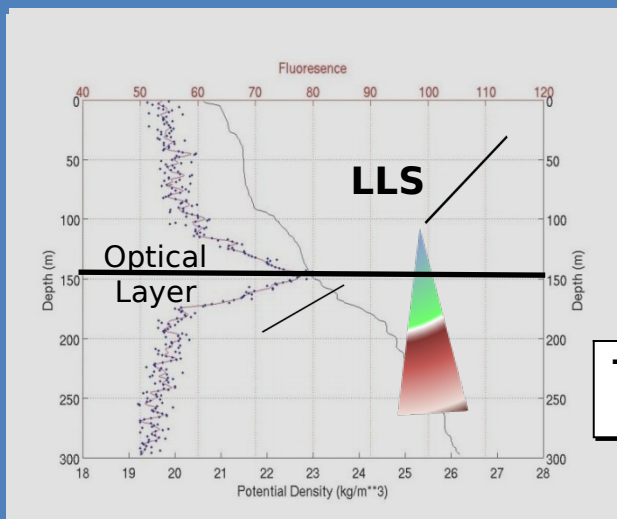
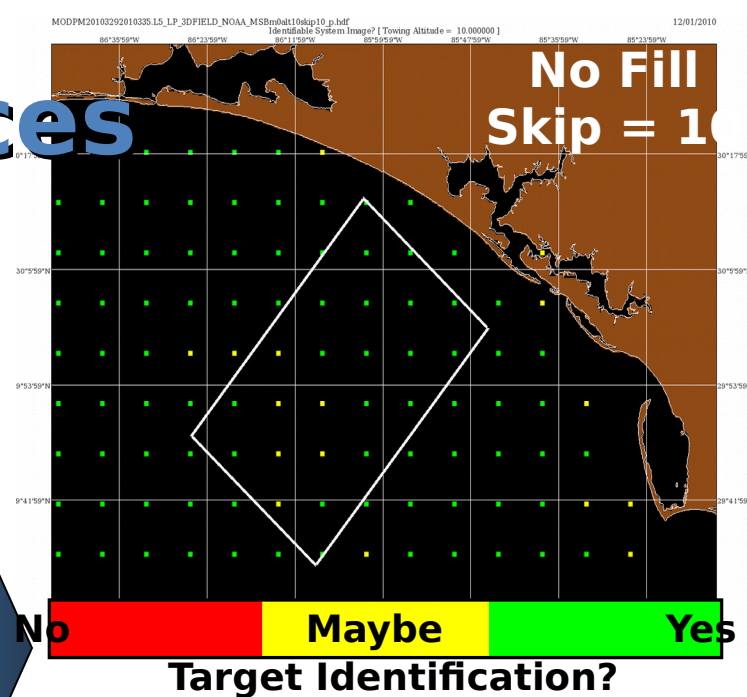


# Performance Surfaces

## Regional Battlespace Characterization 3d optical profiles



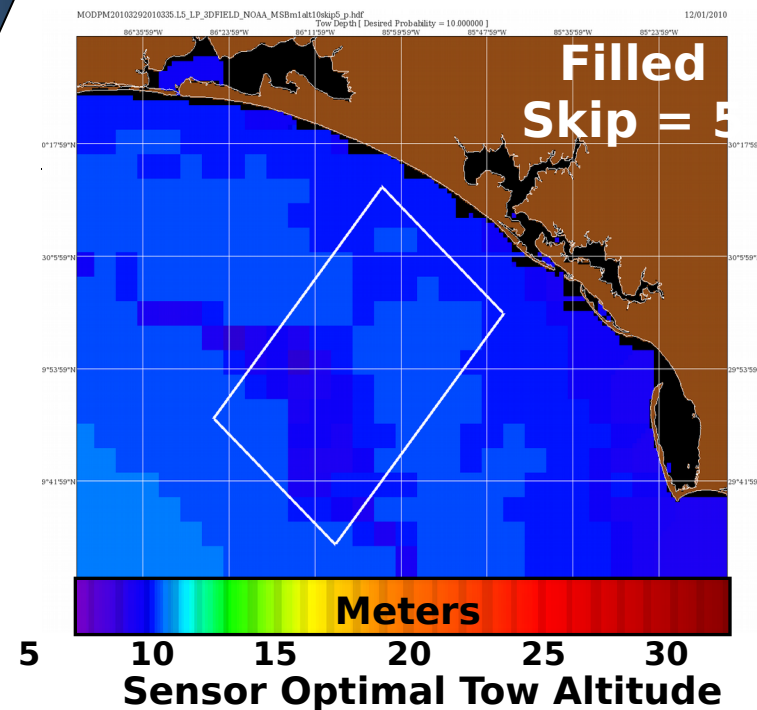
Regional laser  
imaging  
performance  
(EODES Model)



EODES  
Point  
Performance  
(BSP)

Tow **Above/Below**  
Optical Layer

Target ID?







# Vulcanex Glider Operations

## Daily MODIS True Color

Page

85°36'W

85°24'W

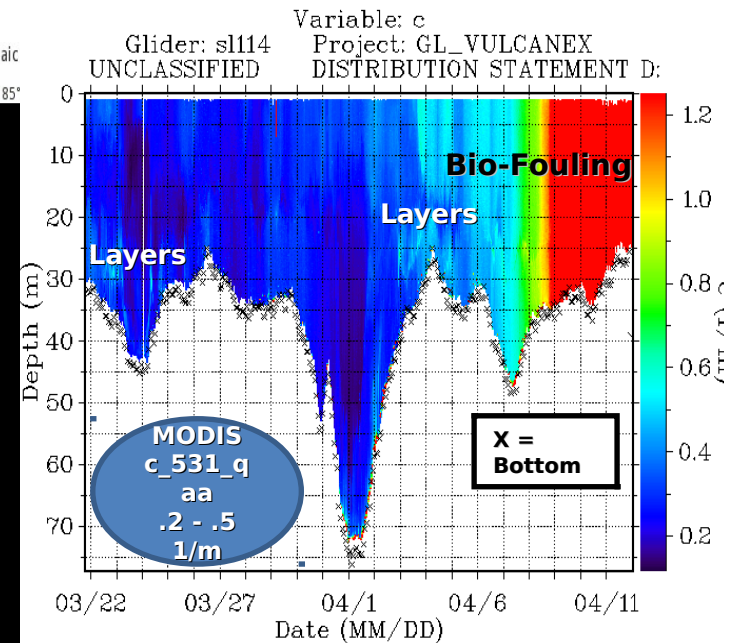
85°12'W

85°

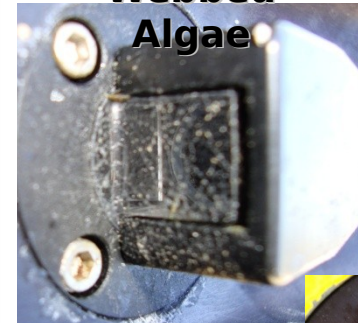
Mon Mar 21 2011 Mosaic

**Today's Data**  
**Previous Day's Data**

- Deployed by NRL & NSWC on 3/21/11
- Recovered by NRL and USCG on 4/12/11.
- Collected optics data for 23 days
- Covered over 384 km
- Collected over 5,868 Profiles



**Webbed  
Algae**



**Barnacles**





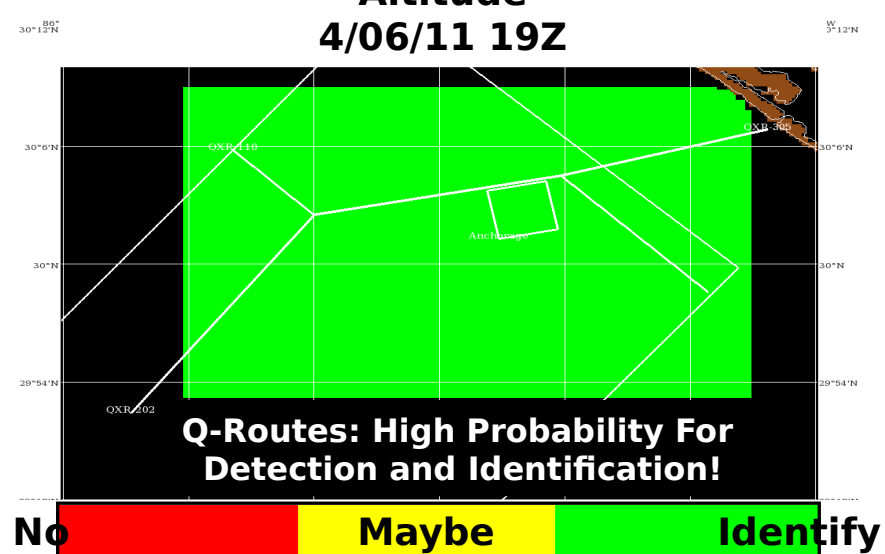
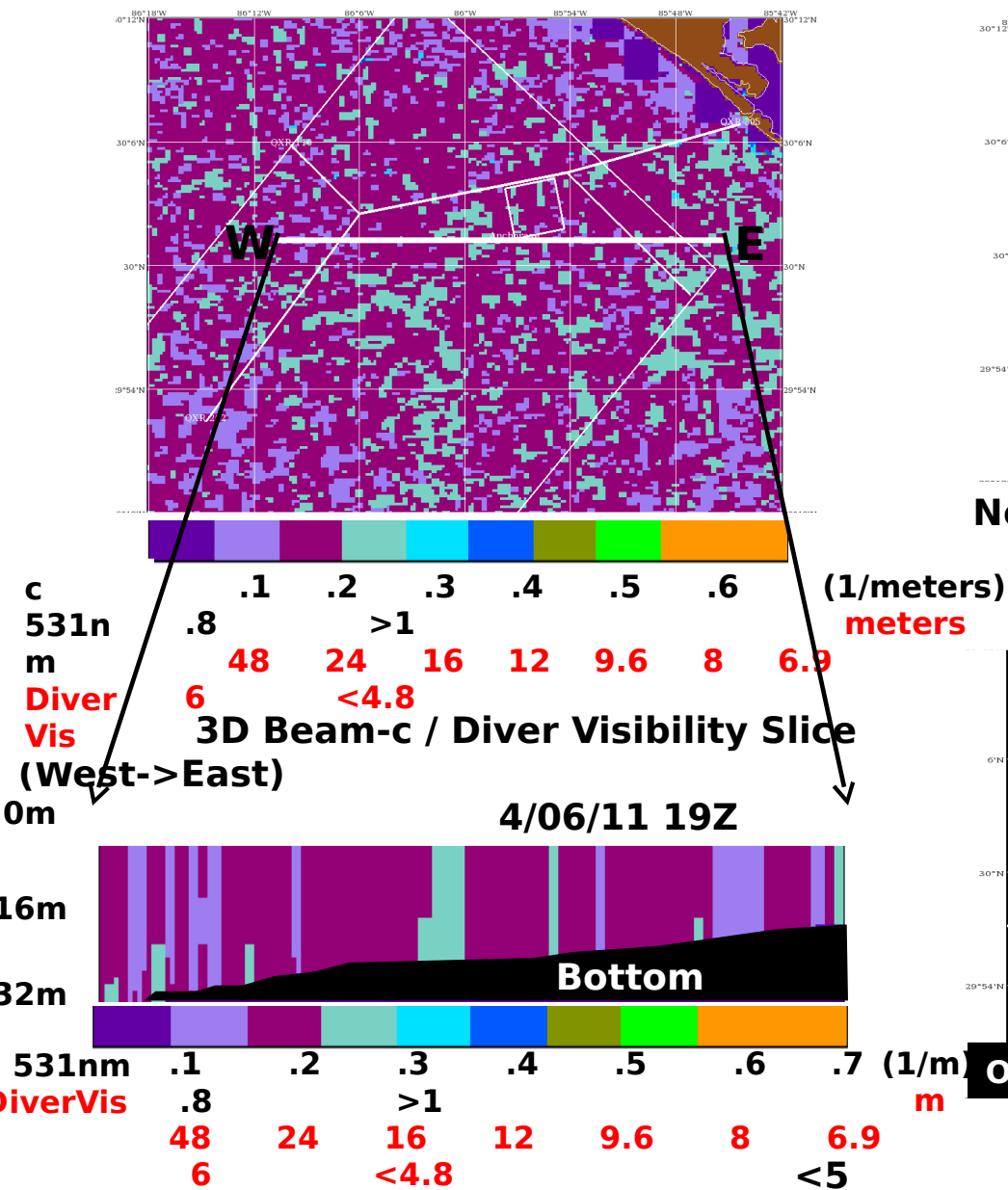
# 24 Exercise Support Products (Nowcast, 24 & 48 Hour Forecast)

## Surface Beam-c / Diver Visibility

4/06/11 19Z

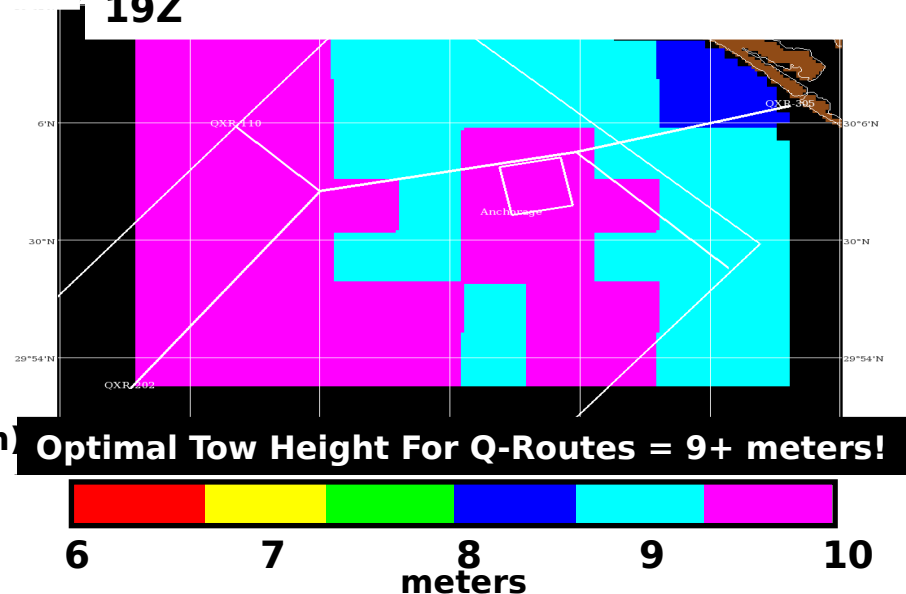
## Target Identification @ 6m Tow Altitude

4/06/11 19Z



## Optimal Tow Altitude - 4/06/11

19Z





# AQS-24 Snippets (4/7/11)

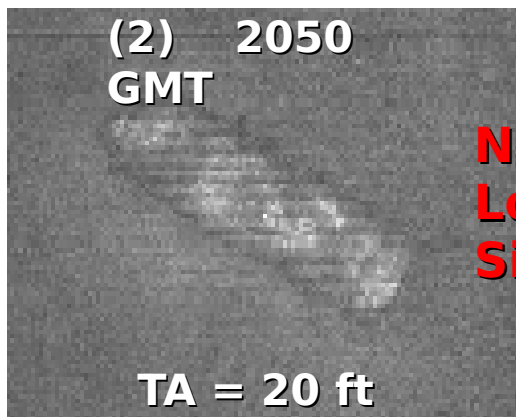
## Step-Ups

(1) 2043 GMT



**Same Object  
Passed Over Multiple  
Times at Increased  
Tow Heights**

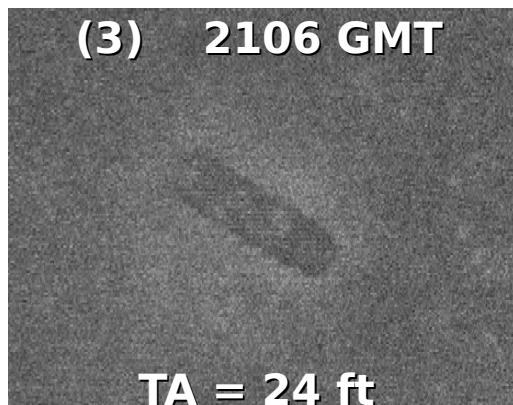
(2) 2050  
GMT



**Note:  
Loss of Contrast,  
Size and Detail**

TA = 20 ft

(3) 2106 GMT

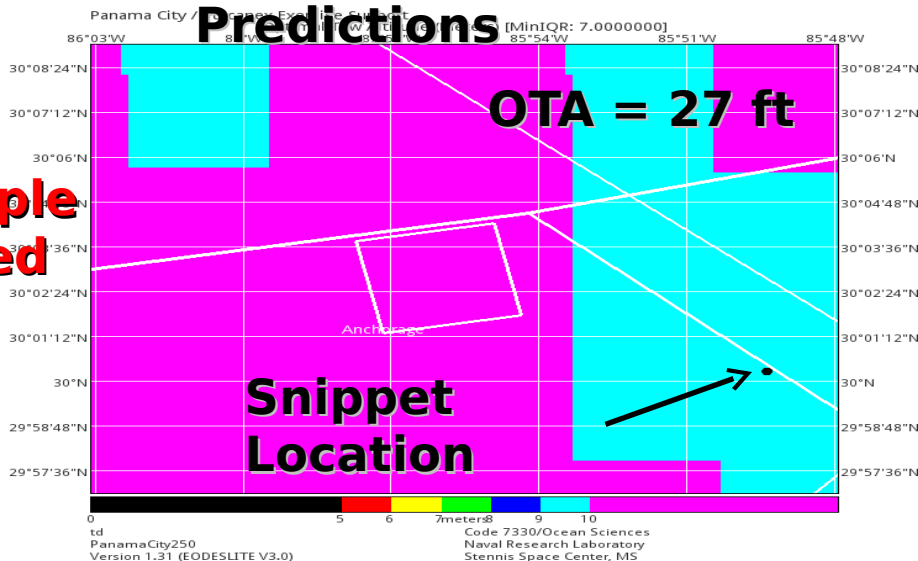


TA = 24 ft

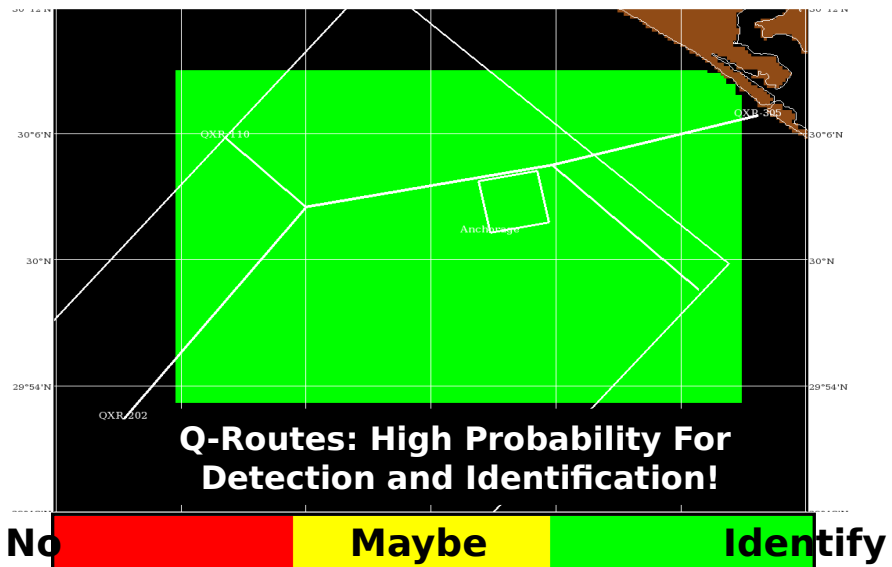
4/7/11

Performance

Predictions



Target Identification @ **19.7 ft** Tow  
Altitude



**~20% Increase  
in Predicted Tow  
Heights = More  
Efficient  
Planning and  
Clearance Times  
with Same  
Probability of**



# Summary

## ***HM-HARP Vulcanex 11-1 Fleet Demonstration Panama City, FL (March 30 - April 08, 2011)***

- First time an ocean optical forecast provided to MCM operations
- Demonstrated capabilities of Tactical Ocean Data System (TODS) - AQS-24 Performance
  - Surfaces (Nowcast/Forecast)
- Provided daily brief of the optical environment (Nowcast/Forecast) to HM-14.
- Obtained validation data for MCM performance surfaces (glider profiles, AQS snippets, BSPs)  
(100% predicted vs. actual ID for mine targets)
- Fleet Feedback:
  - Products were *crucial* to the overall assessment of the squadron's capabilities
  - Predicted optimal tow heights provided a baseline to brief pilots and air crewman prior to their missions (*20% increase in predicted tow heights*).
  - Correlation to post-mission BSP resulted in similar water column assessment
  - Products were user friendly and provided useful and reliable information for mission

# Summary (Continued)

## Impact on Warfighter:

- Option to input user defined tow height (better image quality -> IQR)
- Predicted/forecasted tow heights provide more efficient mine clearance planning and timeline with same probability of identification
- Increase in probability of detection/identification using tow heights based on predicted optical 3D environment.
- Helps UMCM dive units with re-acquisition and ID missions by providing a predicted 3D diver visibility performance surface.
- Forecasts of subsurface current velocities and direction provides important mission planning information for:
  - sweeping moored mines
  - diver deployment